

# Toyo Tanso Third R&D Strategy Briefing

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Held on December 9, 2021  
**Toyo Tanso Co., Ltd.**

# 1. Research & Development in Sustainability Management

Establish a de facto standard globally and become the

**"Quality Leader on carbon"**

- ✓ Achieve good quality/cost from a customer standpoint
- ✓ Provide inspiring new products

## Key initiatives

**Enhancement and innovation of production technology**

**Reinforcement of overseas expansion efforts**

**Learn customer needs in each region**

**Use small starts to develop with speed**

- Globalize R&D centers
- Utilize/collaborate with academia overseas

# Integration of Research & Development Strategies and Sustainability Strategies

**April 2021**  
**Commercialization through collaboration with outside entities**  
 ▶ Began selling platinum-supported CNovel

**June 2021**  
**Established a Sustainability Committee**  
 ▶ Strategic strengthening toward resolving social issues

**July 2021**  
**Endorsement of TCFD recommendations**  
 ▶ Strengthened processes for reducing greenhouse gases, etc.

## Sustainability Committee

1. ESG Value Creating and Promoting Group


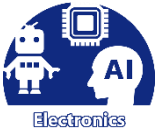



2. Sustainable Consumption and Production Group

3. People and Organizational Vitalization Group

Development issues

Issues	
Management	Clearly state corporate philosophy / vision / policy
	Clearly state sustainability policy
Growth strategy /business	Resolve social issues through business (materiality identification / KPI)
	<b>Promote development/sale of ESG-compatible products</b>
Production	<b>Reduce environmental impact / CO<sub>2</sub> and other GHG</b> <b>Take action on energy conservation / energy creation / resource conservation</b> <b>Improve productivity through automation</b>
	<b>Reduce industrial waste</b>
Procurement quality	<b>Respond to product quality / environmental regulations</b>
	<b>Promote sustainable procurement</b>
Environment / safety / human resources and general affairs / legal affairs	Utilize human capital and improve productivity
	Promote safety, sanitation, and healthy management
	Respect human rights / prevent harassment / improve morals
	Promote diversity / participation by women
	Strengthen corporate governance
	Promote risk management and BCP
	Compliance / protect information assets and intellectual property
	All manner of social contribution activities

## Promoting research & development in the five priority growth areas toward contributing to society through the development of ESG-compatible products

Priority growth area	Key development themes
 <p><b>Energy</b></p>	<ul style="list-style-type: none"> <li>• C/C components for solar panel manufacturing</li> <li>• Catalytic carriers for fuel cells</li> </ul>
 <p><b>Electronics</b></p>	<ul style="list-style-type: none"> <li>• Graphite materials for power semiconductor manufacturing</li> <li>• Improvement of metal-coated graphite materials</li> </ul>
 <p><b>Mobility</b></p>	<ul style="list-style-type: none"> <li>• High-density C/C composites for oil quenching</li> <li>• Resin material for injection molding</li> </ul>
 <p><b>Social Infrastructure</b></p>	<ul style="list-style-type: none"> <li>• Carbon materials for chemical plants</li> </ul>
 <p><b>Life science</b></p>	<ul style="list-style-type: none"> <li>• Carbon brushes for home appliances</li> <li>• Carbon materials for medical equipment</li> </ul>

- Bring in technologies from outside the company  
Examples of joint research / commissioned research
- Exit-focused application research

**Joint research into SiC evaluation techniques**  
National Institute of Advanced Industrial Science and Technology (TPEC)

**Commissioned development on recycled water purification**  
Toyo University

**Joint research into platinum support**  
Doshisha University

- Basic research  
**Joint research into porous carbon**  
Oita University

**Joint research into carbon brushes**  
Nippon Institute of Technology

**The environment is positioned as the key theme that forms the core of the five priority growth areas**

# New Product Families Commercialized in the Past Year



## Versatile graphite material IG-41

With higher permeability to gases than our standard isotropic graphite material IG-11, IG-41 is well suited for many uses at industrial plants, including in air bearings and filters.



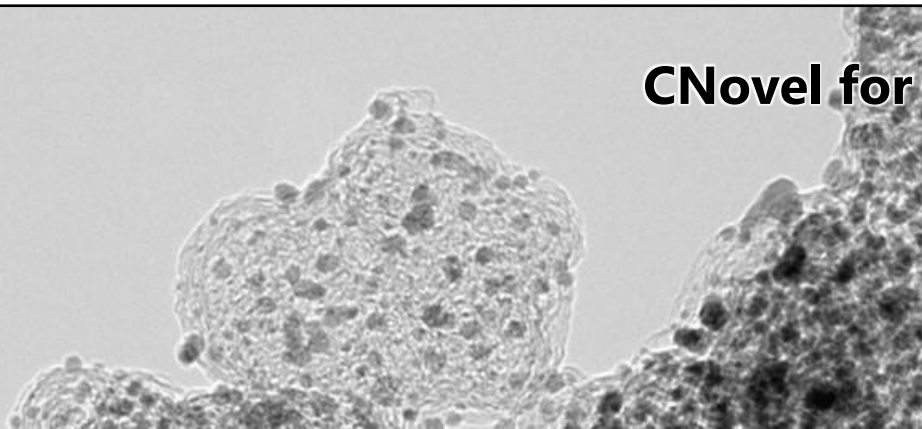
## Lead-free grounding brush MX-80B

The materials reduce environmental impact. Becoming popular among railway companies inside and outside Japan.

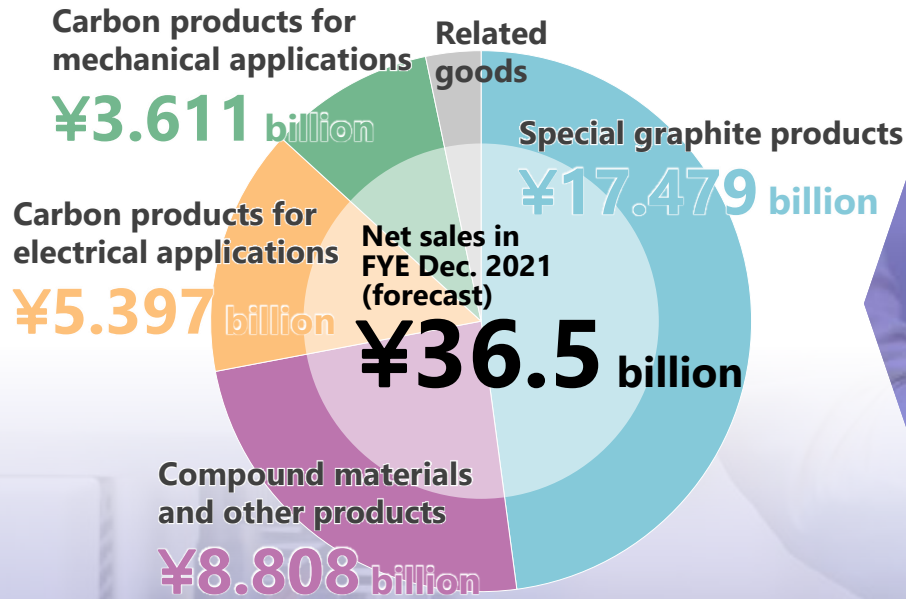


## CNovel for fuel cells (for testing) MH-18-50PT

Commercializing through collaboration with outside entities, accelerating overseas expansion. Highly acclaimed by leading companies, spreading around the world over time.



# Resources Devoted to Research & Development



Three-year average R&D expense component of consolidated sales

**3.1%**

\*Competing carbon manufacturer A: 1.0%  
Competing carbon manufacturer B: 1.0%  
Competing carbon manufacturer C: 0.4%

Groupwide R&D expense total  
(FY2021 plan)

**¥1.32 billion**

**Optimal allocation of resources  
for overall strategy**

- Fundamental development
- Application development
- New materials / new technologies
- Production technology
- Evaluative analysis

**Advance research and development to handle environmental challenges faced by customers in each business sector. And be sure to seize the business opportunities that are expected to arrive.**

## Energy

[Power generation]

Grounding brushes for power generation  
Components for manufacturing solar power generators  
Next-generation nuclear power reactor core materials

[Fuel cells]

Jigs for manufacturing electronic components



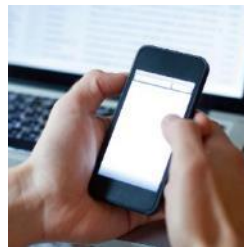
## Electronics

[Semiconductors]

Components for crystal growth  
Components for wafer processing

[Electrical parts]

Jigs for manufacturing electronic components



## Mobility

[Train]

Pantograph sliders

[Aircraft]

Engine parts manufacturing

[Automotive]

Carbon brushes for fuel pumps

Gaskets



## Social infrastructure

[Communications]

Components for manufacturing fiber optics  
Components for manufacturing cables

[General industry]

Packings  
Seal ring bearings



## Life science

[Medical care]

Target materials for CT scan systems  
Chromatographic column fillers

[Home appliance]

Components for manufacturing LEDs  
Carbon brushes for cleaners





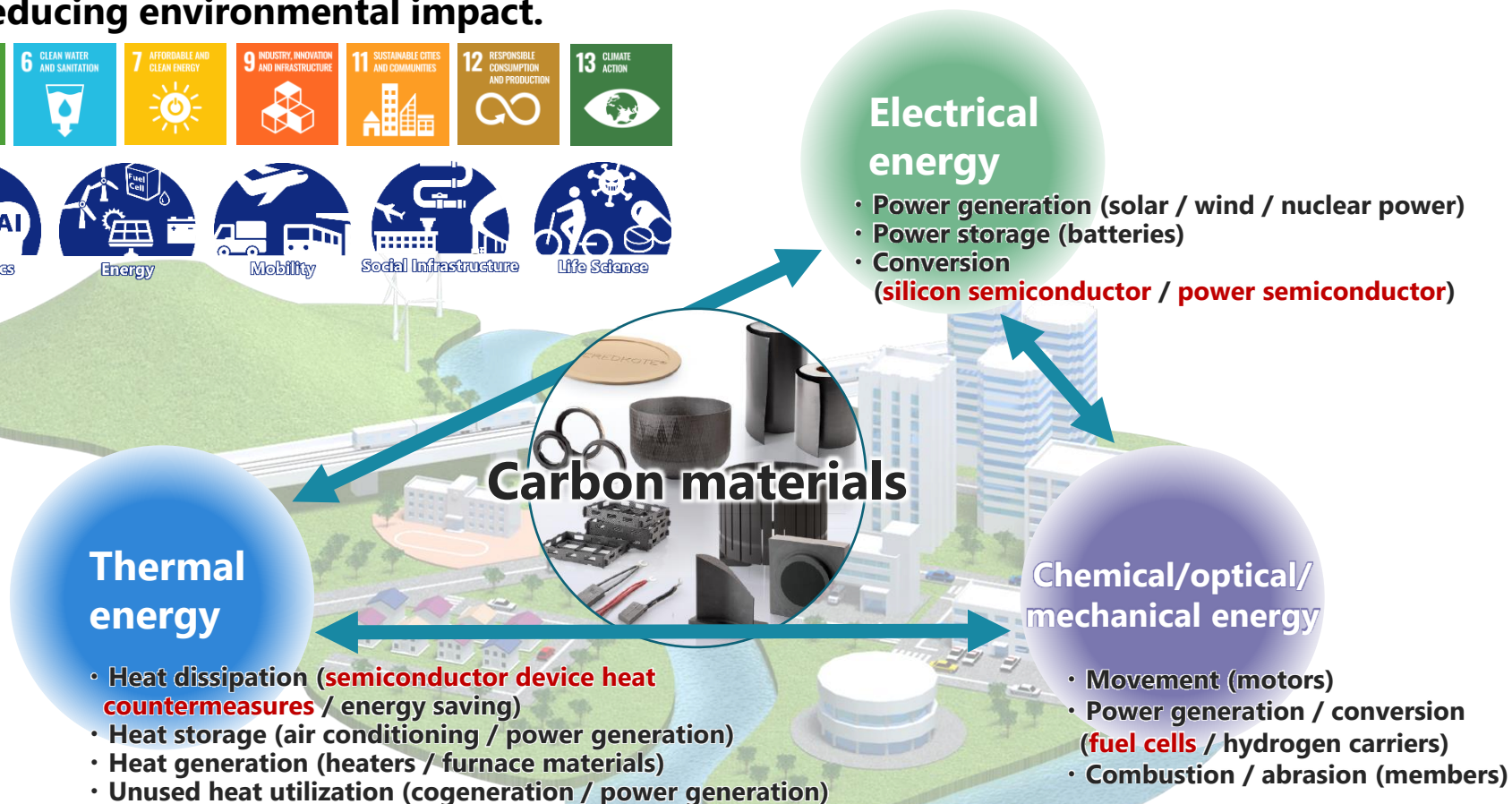
## **2. Outlook for Technology / Developed Products**

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### **Development of Carbon Materials that Underpin Carbon Neutral Industry**

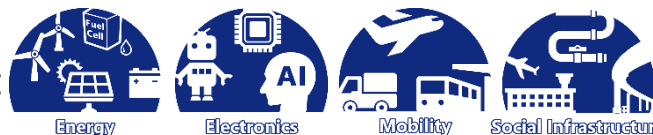
# Carbon Materials that Underpin Carbon Neutral Industry

Interconversion of Energy and Industry, and its Relation to Carbon Materials  
 Industry is built on the interconversion of various forms of energy. Maximizing conversion efficiency by minimizing loss during conversions can substantially reduce CO<sub>2</sub>. Thus, high performance is required of electronics involved in energy interconversion. To achieve high performance, carbon materials—an integral part of electronics manufacturing—continue to evolve, and are directly and indirectly involved in reducing environmental impact.

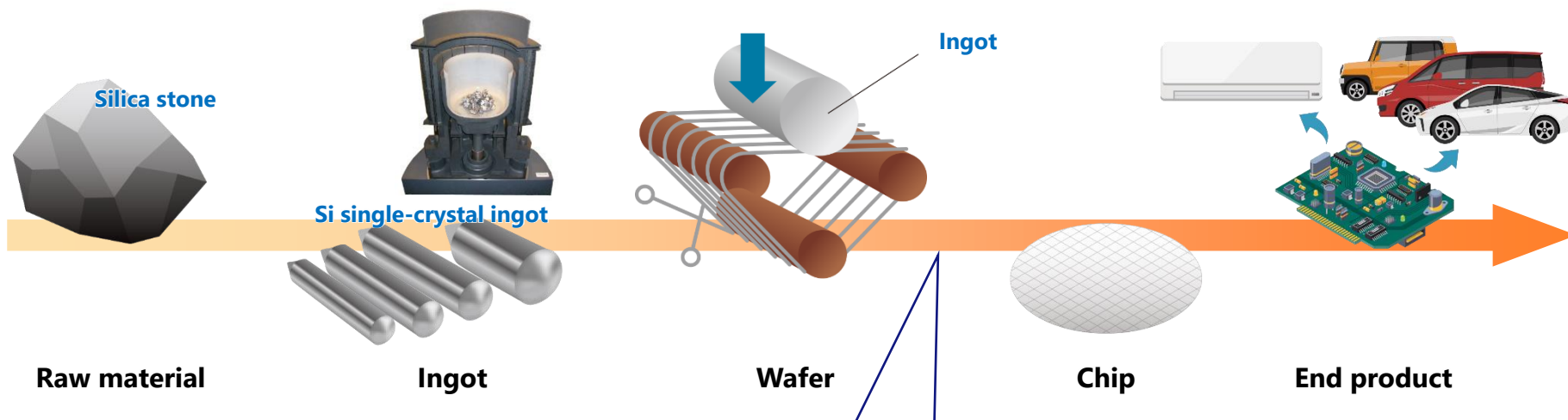


# Technological Development for Materials for Semiconductor Manufacturing (1)

Corresponding Toyo Tanso targets:

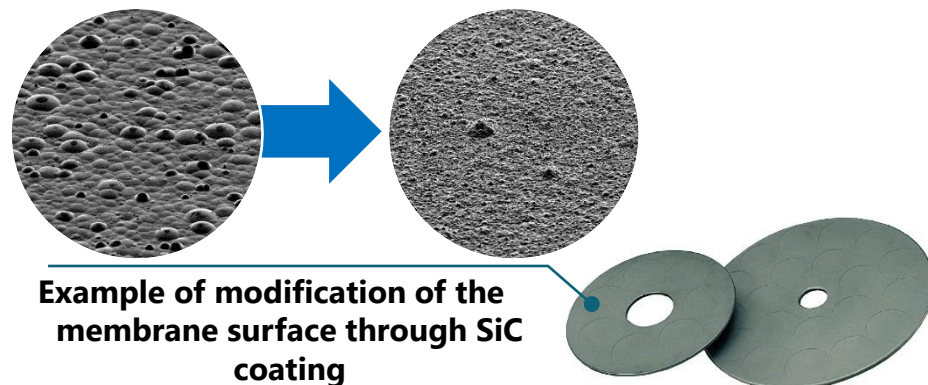


## Si wafer production process



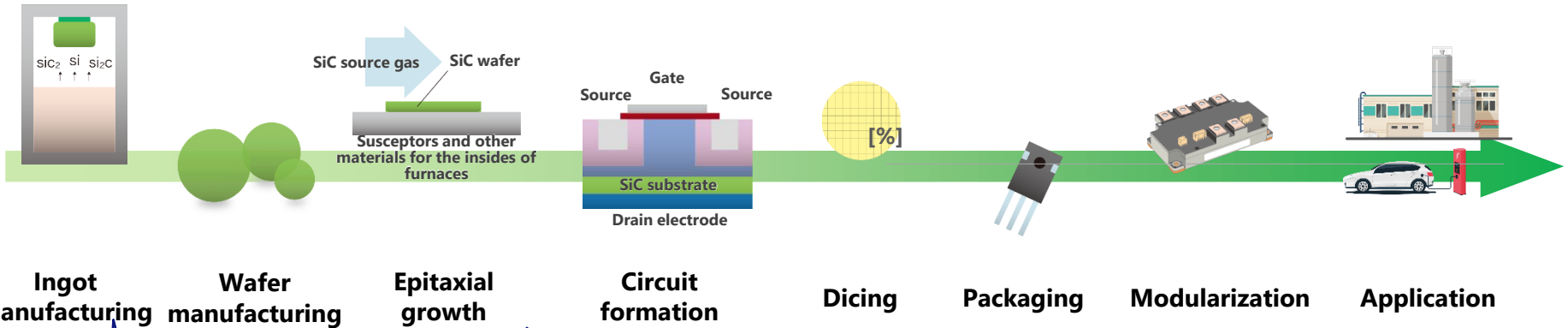
## Epitaxial Si materials

- Promotion of technologies for improvement (e.g. membranes, purity) to respond to customers' constantly advancing, ever-diversifying needs
- Improving the technology of processes based on customer needs
- Currently developing technology to extend lives through membrane improvement, technology to improve purity to satisfy future quality requirements



# Technological Development for Materials for Semiconductor Manufacturing (2)

## SiC wafer production process



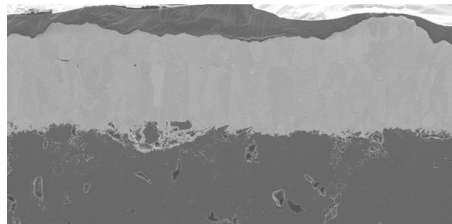
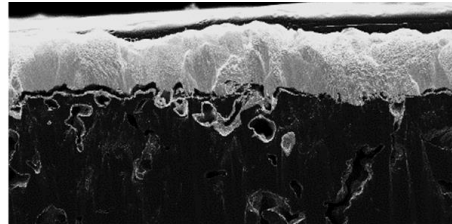
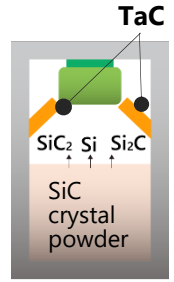
■ Structural components for single-crystal SiC growth systems (inching up, adding durability)

■ Components for SiC wafer epitaxial growth systems (adding durability, membrane improvement)

Market growth for graphite components for SiC semiconductors



Component cone for sublimation method (TaC)



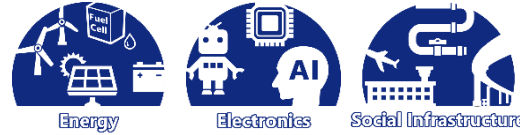
TaC coating parts

Well over double-digit growth expected  
High growth also projected for our sales

Graphite crucibles

# Aluminum Nitride: A Thermolytic Material of Growing Importance

Corresponding Toyo Tanso targets:

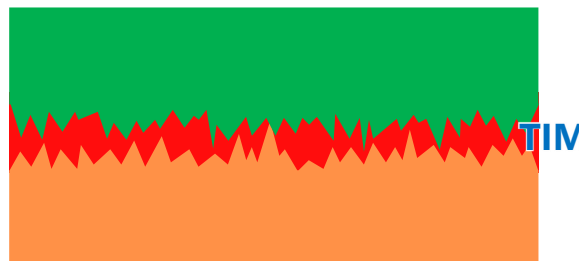
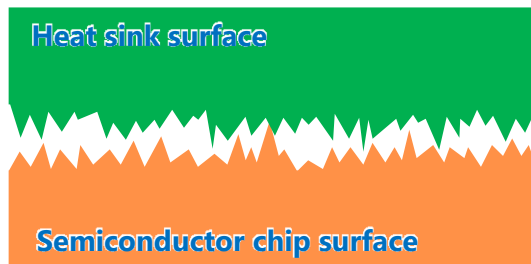


## Pioneering for TIM (Thermal Interface Materials)

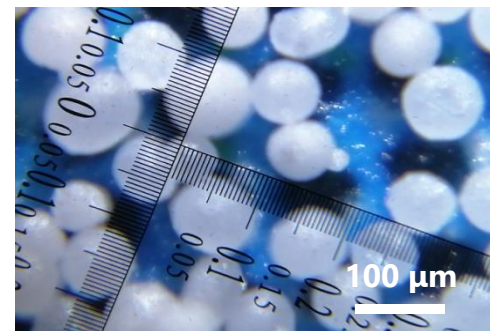
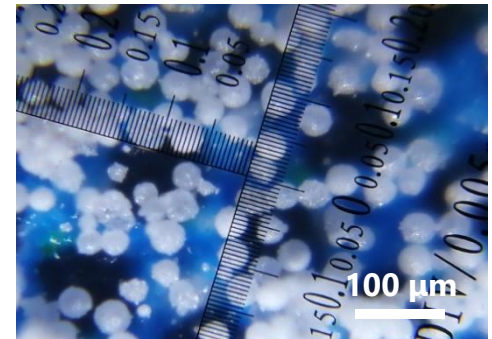
- The market is electronic component packages and thermal interface materials (sheets, grease)
- Chinese TIM filler market
  - ➔ Projected demand for AlN of 150 t/year for 5G base stations alone

### ■ Development of AlN particle filler for TIM in the Chinese market

- Established manufacturing technology, customer assessment ongoing in China
- Excellent cost competitiveness based on homegrown heat treatment technology and in-house production of the graphite materials needed for manufacturing
- Commercialization schedule for 2022

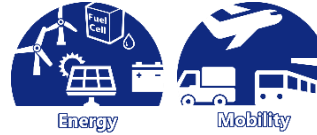


Raising the adhesion of the interface improves thermal conductivity



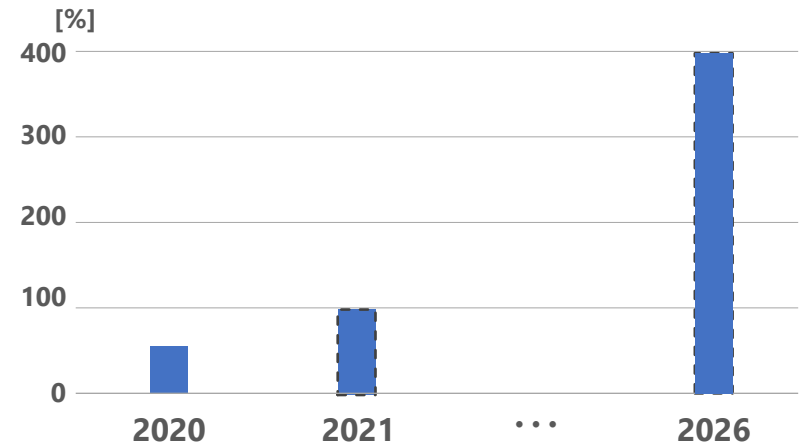
# Outlook for CNovel™ Products

Corresponding Toyo Tanso targets:



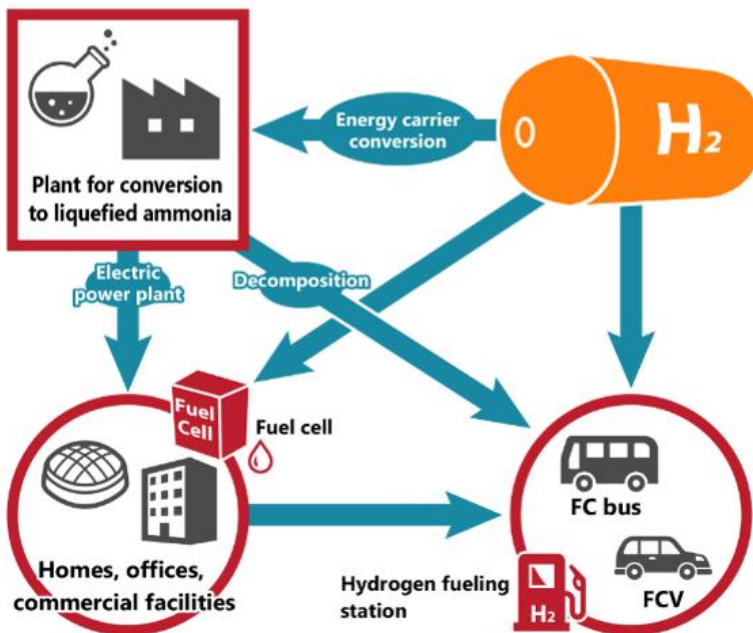
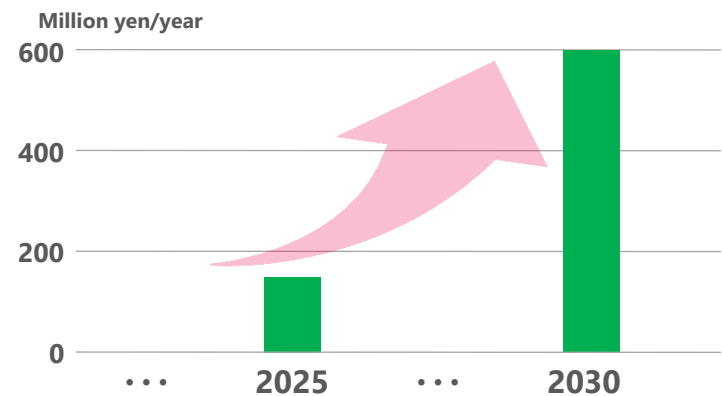
- Sales expected to quadruple between now and 2026
- CNovel for fuel cells expected to grow an average of 30-35% per year over the medium to long term

## Sales figures and projections for CNovel overall



\*Comparison to FY2021 actual sales

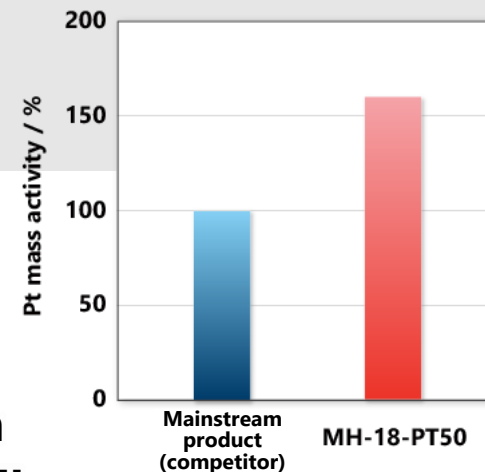
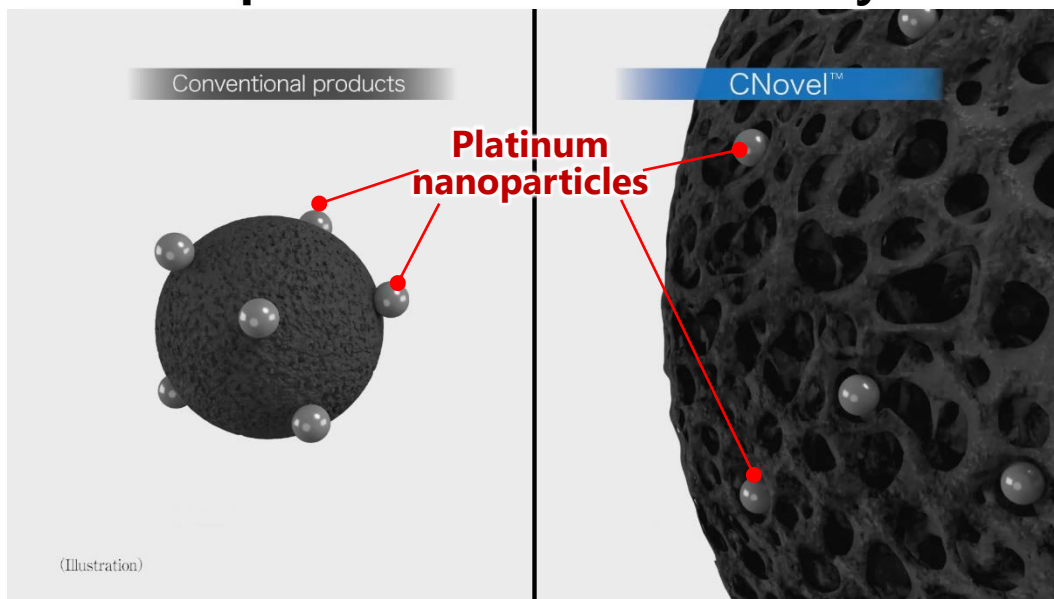
## Medium- to long-term sales targets for CNovel for fuel cells



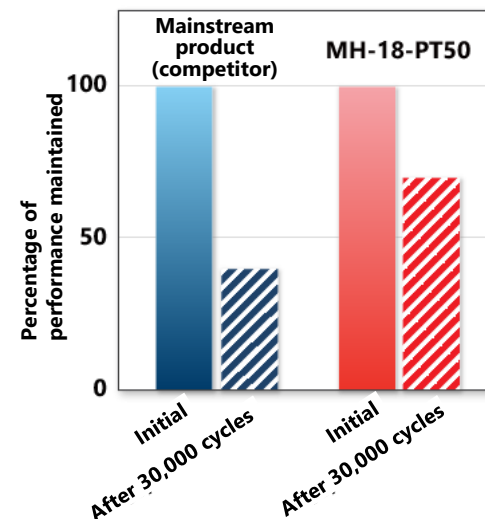
# CNovel™: Product Expansion through Collaboration with Outside Entities

## Commercialization of electrode catalyst for fuel cells MH-18-50PT

- Toyo Tanso and N.E. CHEMCAT Corporation have collaborated to commercialize a platinum catalyst using CNovel. Selling around the world since April 2021
- N.E Chemcat achieved optimal dispersion of platinum
- Advanced fuel cell performance and extended fuel cell life compared to conventional catalytic carriers



Mass activity comparison\*1



Durability comparison (DOE protocol)\*2

(Image courtesy of N.E. Chemcat)

\*1: Measurement results based on Anode/Cathode = H<sub>2</sub>/O<sub>2</sub>, MEA Cathode

\*2: Measurement results based on DOE MEA durability evaluation condition 0.65-0.95V, 30000 cycles

## **3. Medium- to Long-term Development Outlook**

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### **Exploring the Frontiers of Environmentally Friendly Technology**

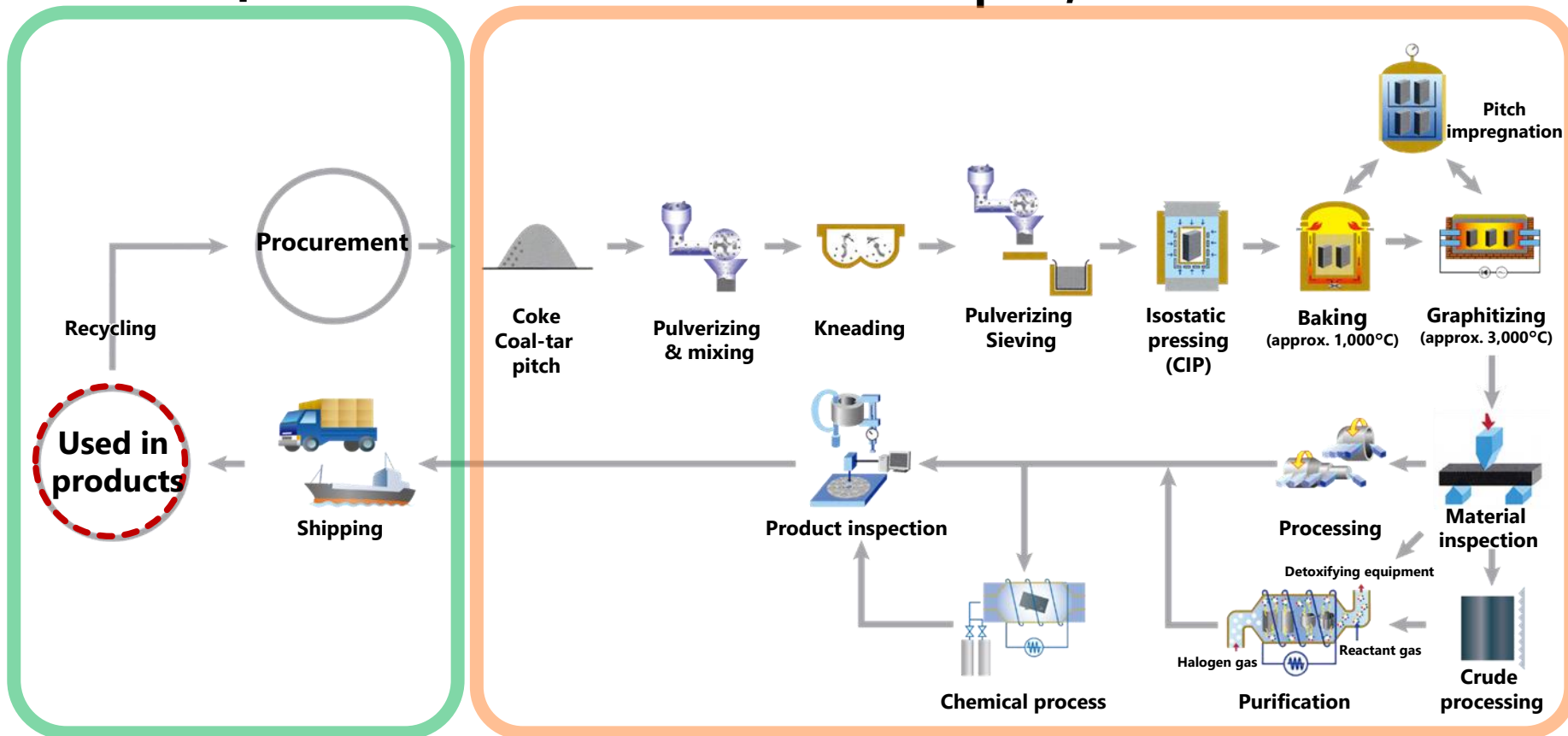


# Medium- and Long-Term Efforts Toward Achieving Carbon Neutrality

## Graphite production process

Scope 3

Scope 1, 2

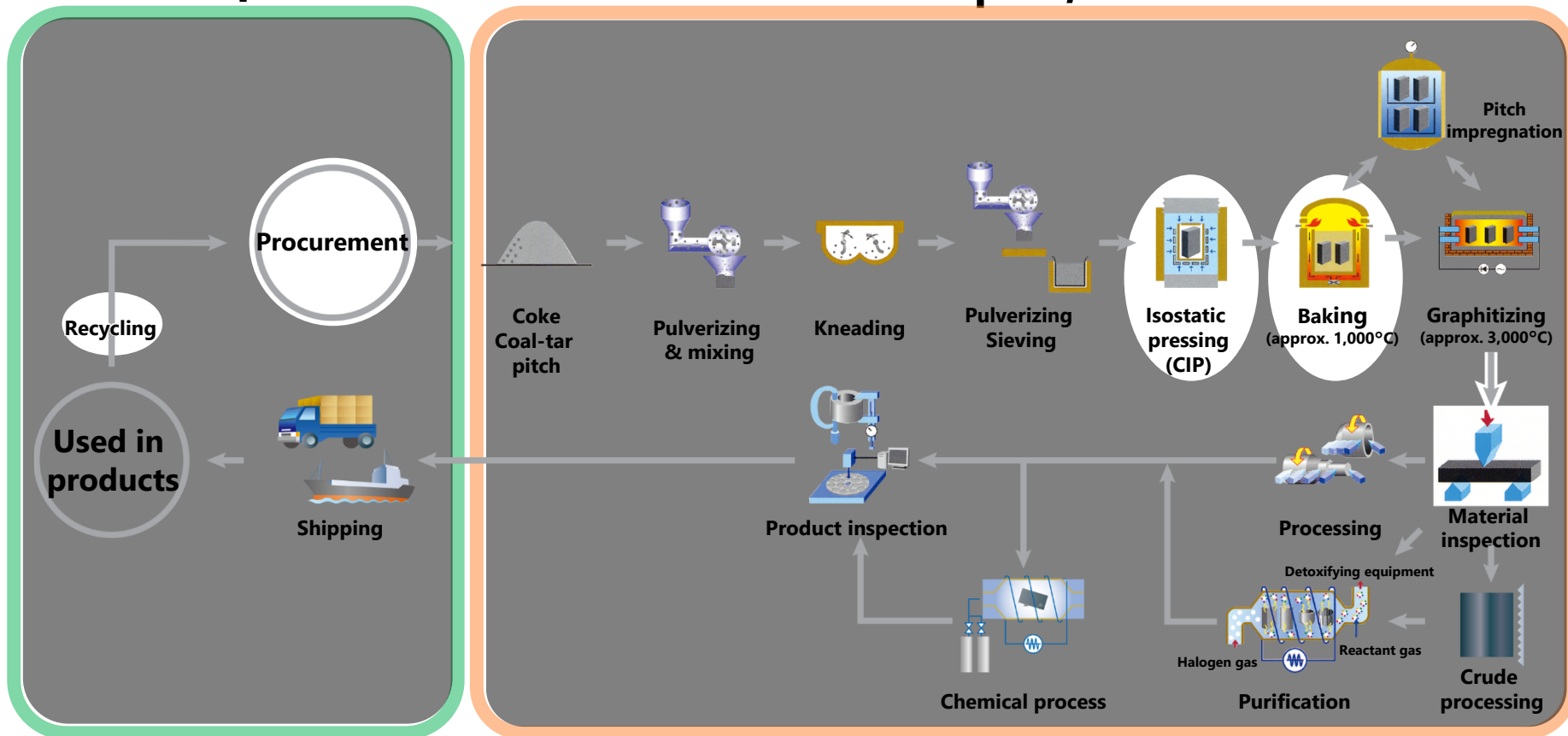


# Medium- and Long-Term Efforts Toward Achieving Carbon Neutrality

## Graphite production process

Scope 3

Scope 1, 2



# Contributing to Carbon Neutrality through Process Innovation

Corresponding Toyo Tanso targets:



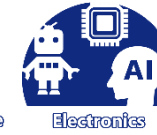
Energy



Mobility



Social Infrastructure



Electronics

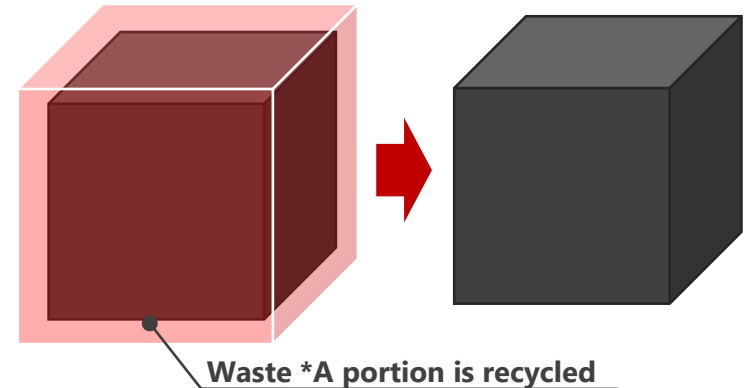


Life Science



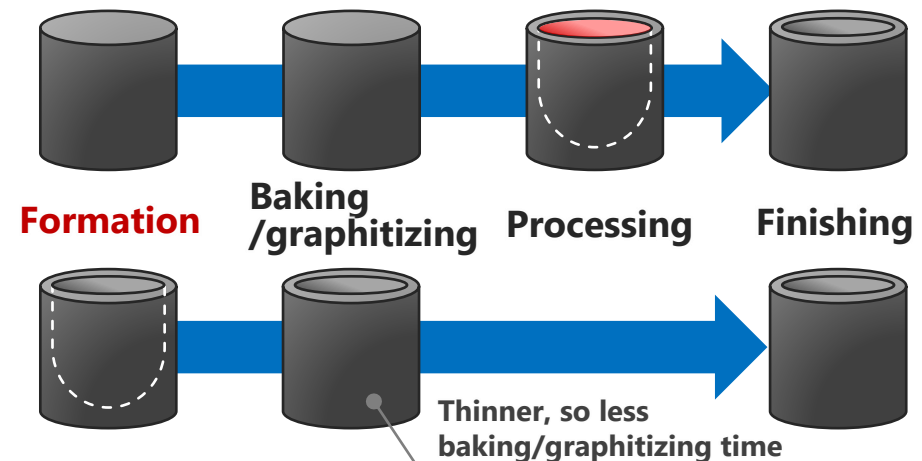
## Reducing graphite material waste by improving the rate of commercialization

- The surfaces of the graphitized blocks we produce have unstable properties, and cannot be turned into products; **➔** they thus become waste
- Revise production process with the aim of eliminating waste

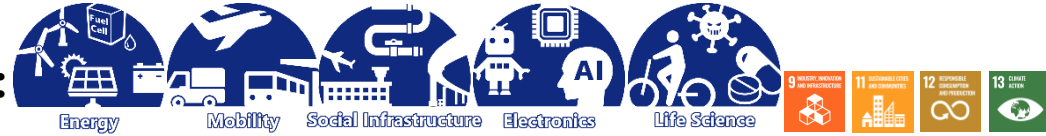


## Reducing waste with shaping control process technology, reducing CO<sub>2</sub> emissions by shortening lead times

- Controlling the shapes of the products in the formation process reduces processing waste
- 20-40% time reduction also possible in the baking/graphitizing processes



Corresponding Toyo Tanso targets:

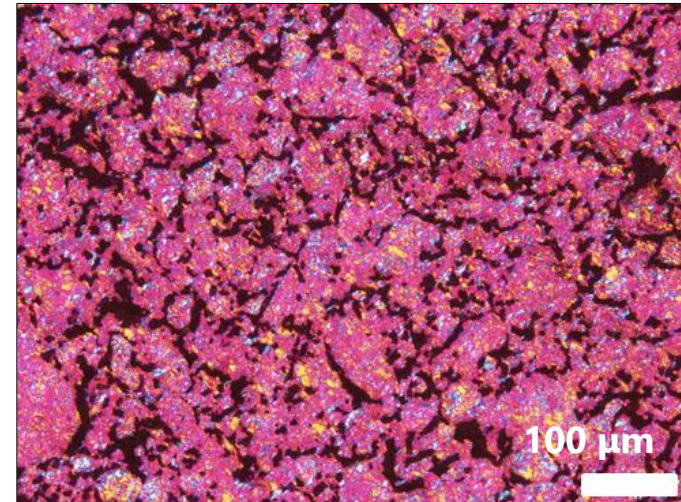


## Promoting the development of process technology for recycling waste carbon materials

- Promoting the development of processes for recycling waste carbon materials internally in pursuit of recycling-oriented manufacturing
- Identifying the processing techniques needed for recycling, the key factors that impact final products, and more to rise to the challenge of creating recycled products
- Plans call for efforts to recycle products used by customers as well

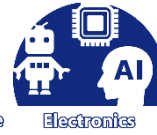


Prototypes of recycled graphite materials made from waste graphite materials



Carbon structure in a polarizing microscope

Corresponding Toyo Tanso targets:

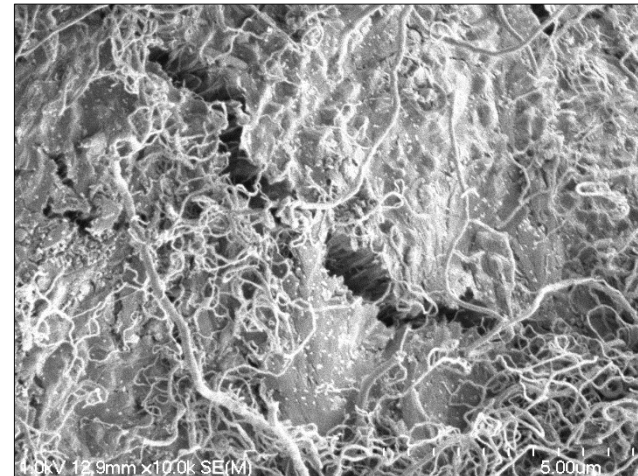
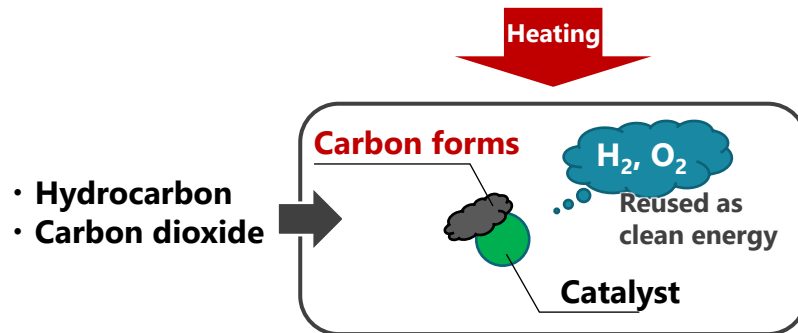


## Researching technology for carbon fixation from low molecular weight carbon compounds

- Collaborating with the National Institute of Advanced Industrial Science and Technology to research technology for synthesizing carbon fine powders from low molecular weight carbon compounds synthesized from CO<sub>2</sub> from the air
- Exploring the possibilities of material sources that do not depend on fossil fuels

Technology

Thermolysis of low molecular weight carbon compounds



Electron microscope image of carbon material synthesized from hydrocarbons

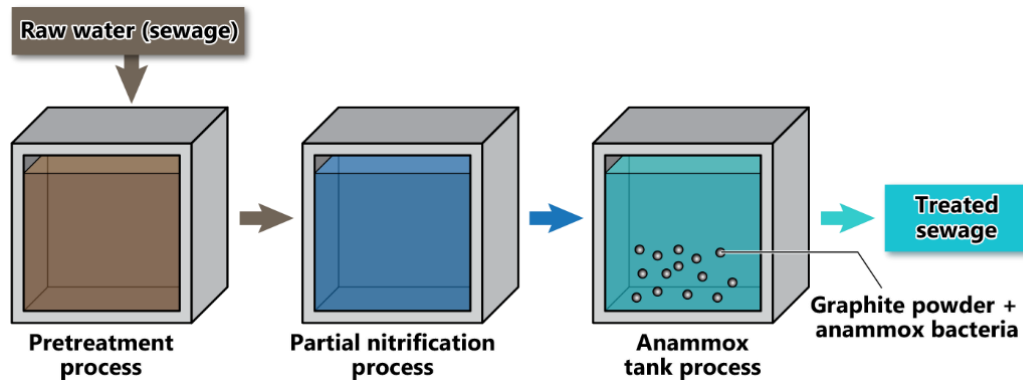
# Contributing to Combined Efforts to Recycle and Reduce the Environmental Impact

Corresponding Toyo Tanso targets:



## Developing highly efficient wastewater treatment technology using recycled graphite powder

- Anammox bacteria are the basis of relatively new biological wastewater treatment technology, and can substantially reduce electricity consumption and chemical usage in the treatment process compared to common nitrification-denitrification technology
- Presently working with water treatment manufacturers and end users on implementation-oriented development



**Wastewater treatment technology system that does not use electricity**



**Experiment for treating wastewater with recycled graphite powder-supported anammox bacteria**

# Overview of Different Scopes of Technology in the Supply Chain

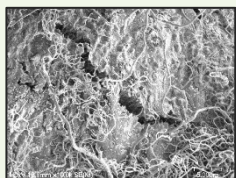
## Upstream

### SCOPE 3

#### Category 3

Fuel- and energy-related activities outside Scopes 1 and 2

Carbon fixation technology



#### Category 5

Waste from operations

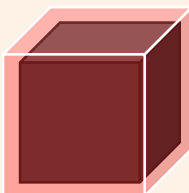


Recycled powder wastewater treatment technology

## Toyo Tanso

### SCOPE 1

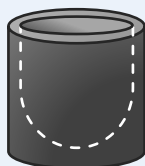
Direct emissions



Reducing waste by improving the rate of commercialization

### SCOPE 2

Indirect emissions from energy sources



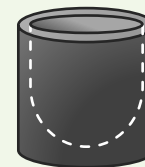
Shortening lead times in the shaping control process

## Downstream

### SCOPE 3

#### Category 10

Processing sold products

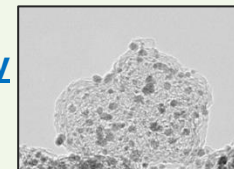


Reducing waste by eliminating processing

#### Category 11

Using sold products

Reducing CO<sub>2</sub> by using fuel cells



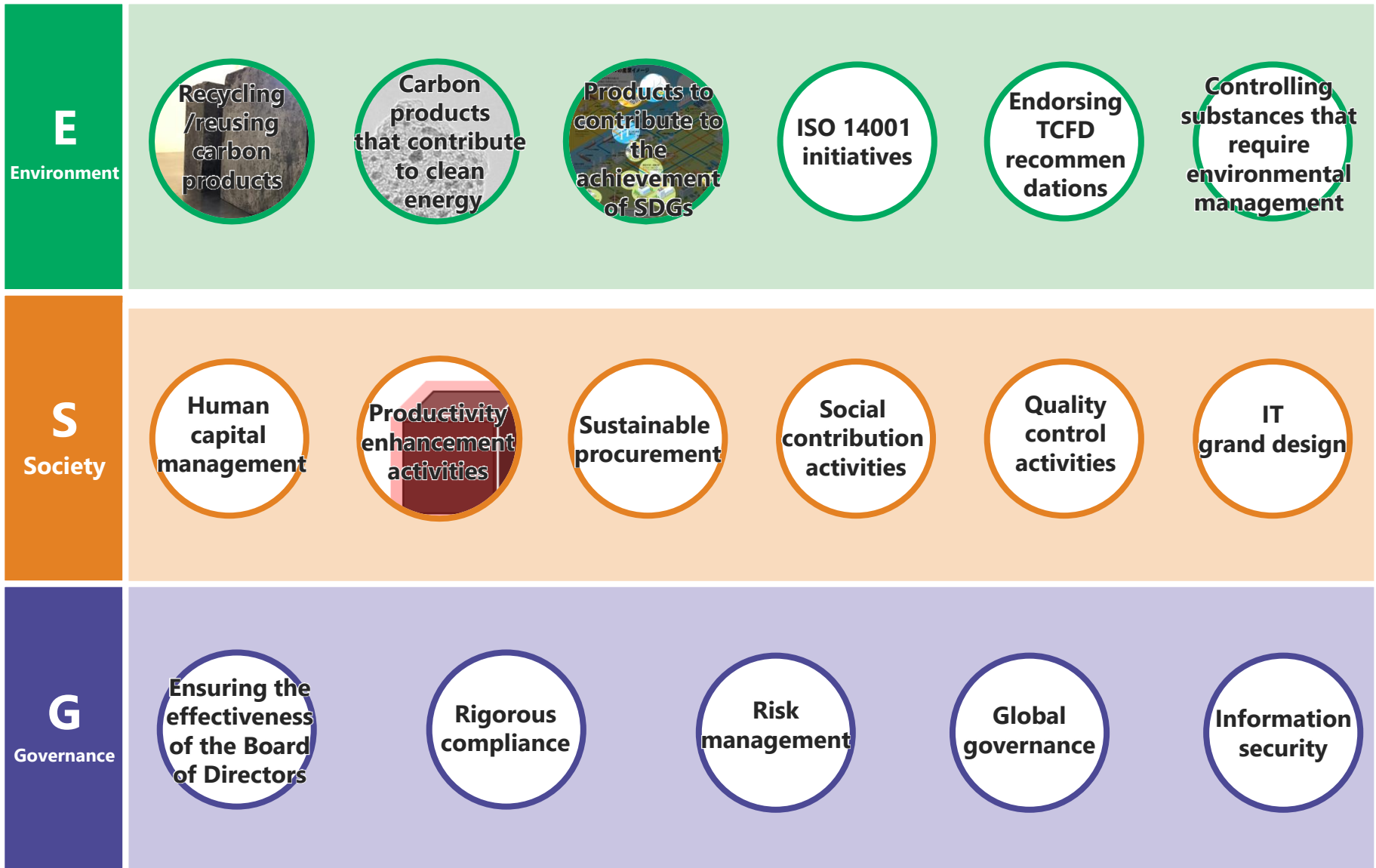
#### Category 12

Waste from sold products



Recycled graphite materials

# Our Efforts Toward Achieving a Sustainable Society




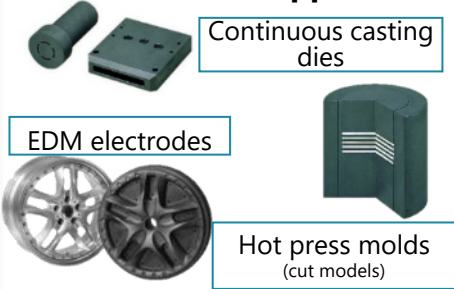



# APPENDIX





# APPENDIX


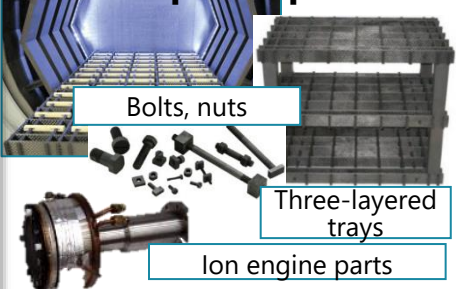

## Product Range Special Graphite Products

	Products	Applications	Related markets	Percentage of sales (FY2021 forecast)
Special graphite products	<p><b>Electronics applications</b></p>  <p>Crucibles      Heaters</p>	<ul style="list-style-type: none"> <li>• Parts for single-crystal silicon manufacturing furnaces (crucibles, heaters)</li> <li>• Parts for compound semiconductor manufacturing equipment (crystal pulling devices, susceptors for MOCVD equipment)</li> </ul>	Semiconductors Solar cells LED Next-generation semiconductors	<b>21.1%</b>
	<p><b>General industries applications</b></p>  <p>Continuous casting dies</p> <p>EDM electrodes</p> <p>Hot press molds (cut models)</p>	<ul style="list-style-type: none"> <li>• Metal casting furnace components (continuous casting dies)</li> <li>• Die manufacturing equipment components (electrical discharge machining electrodes)</li> <li>• Industrial furnace components (heaters, trays)</li> <li>• Optical fiber manufacturing components (heaters, furnace core pipes)</li> </ul>	Automotive Aircraft Semiconductors Home electronics Industrial machines Optical fibers	<b>21.6%</b>
	<p><b>Other</b></p>  <p>High-temperature gas reactor core materials</p> <p>CT device parts</p>	<ul style="list-style-type: none"> <li>• Silicon semiconductor manufacturing equipment components (ion implanter electrodes, glass sealing jigs)</li> <li>• High-temperature gas-cooled reactor structural components (furnace core materials)</li> <li>• Nuclear fusion reactor structural components (furnace wall materials)</li> <li>• CT scanning components (target materials)</li> </ul>	Semiconductors Nuclear power Aerospace Medical care	<b>5.2%</b>

# APPENDIX

## Product Range Carbon Products for General Industries

	Products	Applications	Related markets	Percentage of sales (FY2021 forecast)
Carbon products for general industries (mechanical applications)	 <p>Mechanical seal</p> <p>Bearings</p> <p>Carbon slider すり板</p> <p>Pantograph sliders</p>	<ul style="list-style-type: none"> <li>• Parts for pumps and compressors (bearings, piston rings, mechanical seals)</li> <li>• Pantograph parts (sliders)</li> </ul>	<p>Industrial machines</p> <p>Railways</p> <p>Ships</p> <p>Automotive</p> <p>Home electronics</p>	<b>9.9%</b>
Carbon products for general industries (electrical applications)	 <p>Small brushes</p> <p>Industrial brushes</p>	<ul style="list-style-type: none"> <li>• Small motor components (vacuum cleaners, washing machines, electric tools)</li> <li>• Large motor components (general industrial, power supply, electrical equipment)</li> </ul>	<p>Home electronics</p> <p>Power tools</p> <p>Railways</p> <p>Automotive</p> <p>Industrial machines</p> <p>Wind-power generation</p>	<b>14.8%</b>

	Products	Applications	Related markets	Percentage of sales (FY2021 forecast)
<b>Compound materials and other products</b> [three major products]	<p><b>SiC-coated graphite products</b></p>  <p>MOCVD susceptors</p>	<ul style="list-style-type: none"> <li>• Silicon, compound semiconductor thin-film manufacturing equipment components (susceptors for MOCVD equipment)</li> <li>• Parts for Si-Epi equipment (susceptors)</li> <li>• Parts for SiC-Epi equipment (susceptors)</li> </ul>	Semiconductors LED Next-generation semiconductors	<b>20.4%</b>
	<p><b>C/C composite products</b></p>  <p>Bolts, nuts</p> <p>Three-layered trays</p> <p>Ion engine parts</p>	<ul style="list-style-type: none"> <li>• Parts for single-crystal silicon manufacturing equipment (crucibles, inner shields)</li> <li>• Parts for polycrystal silicon manufacturing equipment (crucibles, trays)</li> <li>• Parts for industrial furnaces (trays, baskets, bolts, nuts)</li> <li>• Nuclear fusion reactor structural components (furnace wall materials)</li> <li>• Small probe engine parts</li> </ul>	Semiconductors Solar cells Automotive Aircraft Nuclear power Aerospace	
	<p><b>Graphitic sheet products</b></p> 	<ul style="list-style-type: none"> <li>• Automotive parts (gaskets)</li> <li>• Parts for synthetic quartz manufacturing (release agent)</li> <li>• Parts for single-crystal silicon manufacturing (protective layer)</li> <li>• Heatsink</li> <li>• Packings for general industries</li> </ul>	Automotive Semiconductors Industrial machines	

# TOYO TANSO

Inspiration for Innovation



**Note: This presentation contains “forward-looking statements” and forecasts of business results. These statements are not historical facts but instead represent the Company’s beliefs regarding future events, many of which, by their nature, are inherently uncertain and beyond the Company’s control. It is possible that the Company’s actual results may differ, possibly materially, from the anticipated results and financial condition indicated in these forward-looking statements.**

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